

Appendix E: Association between Per Capita Shipments and Opioid Mortality Rate
Using Year and County Fixed Effects
2006–2018

	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Constant		
Coefficient	-21.0981	-22.6620
Standard Error	(14.5614)	(27.7734)
T-stat	-1.4489	-0.8160
P-Value	(0.1475)	(0.4146)
Sum of Shipment Variables		
Coefficient	0.652	0.434
Standard Error	0.200	0.408
Lower Bound (95% CI)	0.261	-0.366
Upper Bound (95% CI)	1.044	1.234
T-Statistic	3.267	1.065
P-Value	0.00110	0.287
Observations	24,621	24,621
R-squared	0.6444	0.6781
Adjusted R-squared	0.602	0.640

Source: 1997–2018 US Census Data; CDC Restricted Mortality; ARCOS; American Community Survey; County Business Patterns (CBP) Datasets; BRFSS; AHRF; CDC WONDER

Note:

- [1] Shipments are defined as shipment per capital per day. Opioid shipments include Fentanyl, Hydrocodone, Hydromorphone, Morphine, Oxycodone, Oxymorphone, Methadone, and Tapentadol.
 [2] A *** indicates a p-value of <0.01; ** indicates a p-value of <0.05; and a * indicates a p-value of <0.1.
 [3] Mortality rate is mortality per 100,000 persons. Illicit Mortality are the deaths with multiple cause of death codes that include Opium, Heroin, Fentanyl, and Unknown Opioids (T40.0, T40.1, T40.4, and T40.6 based on ICD-10 Codes). Prescription Mortality are the deaths with multiple cause of death codes that include other prescription opioids (T40.2 and T40.3 based on ICD-10 Codes) but not any illicit mortality codes (T40.0, T40.1, T40.4, and T40.6 based on ICD-10 Codes).
 [4] All regressions are population-weighted. Standard errors are clustered at the county level.

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Shipment per capital per day		
Coefficient	0.3655***	-0.1309
Standard Error	(0.1228)	(0.1527)
T-stat	2.9767	-0.8569
P-Value	(0.0029)	(0.3916)
1-year Lagged Shipment		
Coefficient	0.1711***	0.0054
Standard Error	(0.0539)	(0.0831)
T-stat	3.1752	0.0651
P-Value	(0.0015)	(0.9481)
2-year Lagged Shipment		
Coefficient	0.1239***	-0.1075
Standard Error	(0.0372)	(0.0707)
T-stat	3.3263	-1.5199
P-Value	(0.0009)	(0.1287)
3-year Lagged Shipment		
Coefficient	0.0741*	-0.0405
Standard Error	(0.0388)	(0.0783)
T-stat	1.9106	-0.5177
P-Value	(0.0562)	(0.6047)
4-year Lagged Shipment		
Coefficient	0.0388	-0.2881**
Standard Error	(0.0478)	(0.1244)
T-stat	0.8142	-2.3162
P-Value	(0.4174)	(0.0206)
5-year Lagged Shipment		
Coefficient	-0.0371	-0.1578**
Standard Error	(0.0455)	(0.0750)
T-stat	-0.8158	-2.1049
P-Value	(0.4147)	(0.0354)
6-year Lagged Shipment		
Coefficient	-0.0511	0.0474
Standard Error	(0.0359)	(0.1269)
T-stat	-1.4246	0.3738
P-Value	(0.1544)	(0.7086)
7-year Lagged Shipment		
Coefficient	0.0343	0.0292
Standard Error	(0.0390)	(0.1578)
T-stat	0.8799	0.1860
P-Value	(0.3790)	(0.8532)

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8-year Lagged Shipment		
Coefficient	0.0365	0.4626*
Standard Error	(0.0660)	(0.2486)
T-stat	0.3801	1.8604
P-Value	(0.7039)	(0.0629)
9-year Lagged Shipment		
Coefficient	-0.1034	0.6144**
Standard Error	(0.1000)	(0.2449)
T-stat	-1.0336	2.5089
P-Value	(0.3014)	(0.0122)
Census Population (Thousands)		
Coefficient	-0.0018**	-0.0086***
Standard Error	(0.0009)	(0.0028)
T-stat	-2.0802	-3.0722
P-Value	(0.0376)	(0.0021)
Percent Male		
Coefficient	19.7771*	140.6639***
Standard Error	(10.7253)	(27.0458)
T-stat	1.8440	5.2009
P-Value	(0.0653)	(0.0000)
Percent Under 15		
Coefficient	1.9884	68.7130**
Standard Error	(10.5814)	(26.7486)
T-stat	0.1879	2.5690
P-Value	(0.8510)	(0.0103)
Percent 15 to 29		
Coefficient	4.6992	20.0235
Standard Error	(9.1638)	(20.1924)
T-stat	0.5128	0.9916
P-Value	(0.6081)	(0.3215)
Percent 30 to 44		
Coefficient	-7.2145	-127.5933***
Standard Error	(8.9689)	(20.2319)
T-stat	-0.8046	-6.3066
P-Value	(0.4211)	(0.0000)
Percent 45 to 64		
Coefficient	15.5049	24.8568
Standard Error	(9.7262)	(17.8339)
T-stat	1.5941	1.3938
P-Value	(0.1110)	(0.1635)



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	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Percent Binge Drinking		
Coefficient	-2.5629	-7.3376
Standard Error	(1.7894)	(5.7526)
T-stat	1.4322	1.2755
P-Value	(0.1522)	(0.2022)
Percent Poor or Fair Health		
Coefficient	-1.8449	9.1236
Standard Error	(2.4381)	(6.9585)
T-stat	-0.7567	1.3111
P-Value	(0.4493)	(0.1899)
Percent Poor Physical Health Days		
Coefficient	0.1016	0.6224
Standard Error	(0.1324)	(0.3860)
T-stat	0.7676	1.6126
P-Value	(0.4427)	(0.1070)
Percent Poor Mental Health Days		
Coefficient	0.1374	-0.4858
Standard Error	(0.1165)	(0.3598)
T-stat	1.1796	1.3500
P-Value	(0.2383)	(0.1771)
Percent Adult Smoking		
Coefficient	3.2639	-7.0760
Standard Error	(2.0713)	(5.2197)
T-stat	1.5756	1.3556
P-Value	(0.1152)	(0.1753)
Percent Diabetes		
Coefficient	-0.0256	-0.1809**
Standard Error	(0.0318)	(0.0836)
T-stat	-0.8044	-2.1632
P-Value	(0.4213)	(0.0306)
Percent Obesity		
Coefficient	0.0064	0.0617*
Standard Error	(0.0122)	(0.0359)
T-stat	0.5220	1.7177
P-Value	(0.6017)	(0.0860)
Cancer Deaths per 100,000		
Coefficient	0.0002	-0.0106***
Standard Error	(0.0012)	(0.0030)
T-stat	0.1769	-3.4873
P-Value	(0.8596)	(0.0005)

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**Appendix E: Association between Per Capita
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Using Year and County Fixed Effects
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	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Medicare Enrollment, aged and disabled/Pop		
Coefficient	-0.4728	-11.8313**
Standard Error	(2.7274)	(4.9852)
T-stat	-0.1733	-2.3733
P-Value	(0.8624)	(0.0177)
Hospices/Pop		
Coefficient	10,674.6719**	-20,063.0000*
Standard Error	(5,307.5361)	(11,586.6963)
T-stat	2.0112	-1.7316
P-Value	(0.0444)	(0.0835)
Veteran Population Estimate/Pop		
Coefficient	16.7728***	-28.0249**
Standard Error	(5.3507)	(14.1182)
T-stat	3.1347	-1.9850
P-Value	(0.0017)	(0.0472)
Hospital Beds/Pop		
Coefficient	-125.9063	459.2236
Standard Error	(140.8684)	(350.3253)
T-stat	-0.8938	1.3108
P-Value	(0.3715)	(0.1900)
Short Term General Hospital Beds/Pop		
Coefficient	87.5784	-227.8284
Standard Error	(142.3184)	(348.2509)
T-stat	0.6154	-0.6542
P-Value	(0.5384)	(0.5130)
Long Term General Hospital Beds/Pop		
Coefficient	127.5610	-190.1050
Standard Error	(137.1219)	(296.6267)
T-stat	0.9303	-0.6409
P-Value	(0.3523)	(0.5217)
Percent Disabled		
Coefficient	3.5276	22.9251**
Standard Error	(3.9092)	(9.8112)
T-stat	0.9024	2.3366
P-Value	(0.3669)	(0.0195)
Percent Uninsured		
Coefficient	-0.0011	0.1826***
Standard Error	(0.0176)	(0.0514)
T-stat	-0.0627	3.5516
P-Value	(0.9500)	(0.0004)

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	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Percent White		
Coefficient	7.3367	32.7329**
Standard Error	(5.8401)	(13.2860)
T-stat	1.2563	2.4637
P-Value	(0.2091)	(0.0138)
Percent Black		
Coefficient	7.0053	31.6020
Standard Error	(8.3777)	(21.7382)
T-stat	0.8362	1.4538
P-Value	(0.4031)	(0.1461)
Percent Hispanic		
Coefficient	-10.5118**	1.3854
Standard Error	(4.5670)	(14.2592)
T-stat	-2.3017	0.0972
P-Value	(0.0214)	(0.9226)
Percent Less High School		
Coefficient	3.5395	-55.5602***
Standard Error	(5.2808)	(13.3119)
T-stat	0.6702	-4.1737
P-Value	(0.5028)	(0.0000)
Percent High School		
Coefficient	-1.1437	-75.7808***
Standard Error	(4.2398)	(13.1344)
T-stat	-0.2698	-5.7696
P-Value	(0.7874)	(0.0000)
Percent Some College		
Coefficient	6.0952	-18.1217
Standard Error	(4.9731)	(11.4548)
T-stat	1.2266	-1.5820
P-Value	(0.2204)	(0.1138)
Employment Ratio		
Coefficient	0.8010	13.6336***
Standard Error	(1.8395)	(4.9397)
T-stat	0.4355	2.7600
P-Value	(0.6633)	(0.0058)
Percent Unemployed		
Coefficient	0.0752**	0.0863
Standard Error	(0.0353)	(0.1175)
T-stat	2.1301	0.7343
P-Value	(0.0333)	(0.4628)

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	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Percent Urban		
Coefficient	-1.9742	-28.7791***
Standard Error	(7.0821)	(10.7333)
T-stat	-0.2786	-2.6813
P-Value	(0.7805)	(0.0074)
Poverty Rate		
Coefficient	0.4029	45.5082***
Standard Error	(2.9731)	(7.7236)
T-stat	0.1355	5.8921
P-Value	(0.8922)	(0.0000)
Median Houshold Income (Thousands)		
Coefficient	0.0214**	-0.1252***
Standard Error	(0.0109)	(0.0405)
T-stat	1.9642	-3.0873
P-Value	(0.0496)	(0.0020)
Percent Ag/M/Const/Util		
Coefficient	7.2682	-0.4888
Standard Error	(5.2412)	(10.6362)
T-stat	1.3868	-0.0460
P-Value	(0.1656)	(0.9634)
Percent Manufacturing		
Coefficient	3.3987	-3.5114
Standard Error	(4.5389)	(10.3318)
T-stat	0.7496	-0.3399
P-Value	(0.4540)	(0.7340)
Percent Retail/Transportation		
Coefficient	4.4846	-3.6840
Standard Error	(4.7228)	(11.3676)
T-stat	0.9496	-0.3241
P-Value	(0.3424)	(0.7459)
Percent Financial and Professional Services		
Coefficient	3.1920	-1.0196
Standard Error	(4.4096)	(10.3028)
T-stat	0.7239	-0.0990
P-Value	(0.4692)	(0.9212)
Percent Health Care and Education Services		
Coefficient	5.5182	1.6216
Standard Error	(4.6208)	(10.0018)
T-stat	1.1942	0.1621
P-Value	(0.2325)	(0.8712)

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	Prescription Opioid Mortality Rate per 100,000	Illicit Mortality Rate per 100,000
Percent Repair, Maintenance, and Other Services		
Coefficient	7.9072	0.5110
Standard Error	(5.3669)	(12.6459)
T-stat	1.4733	0.0404
P-Value	(0.1408)	(0.9678)
Percent in Management, business, science, and arts occupations		
Coefficient	-2.6012	-2.0858
Standard Error	(4.7835)	(10.6514)
T-stat	-0.5436	-0.1958
P-Value	(0.5866)	(0.8448)
Percent in Service occupations		
Coefficient	-0.1166	-21.5386*
Standard Error	(4.8809)	(12.1725)
T-stat	-0.0239	-1.7695
P-Value	(0.9809)	(0.0769)
Percent in Sales and office occupation		
Coefficient	-2.6350	-33.7823***
Standard Error	(5.1128)	(11.5775)
T-stat	-0.5154	-2.9179
P-Value	(0.6063)	(0.0036)
Percent in Natural resources, construction, and maintenance occupations		
Coefficient	3.5723	3.3925
Standard Error	(4.7642)	(12.7387)
T-stat	0.7496	0.2663
P-Value	(0.4534)	(0.7900)
Total M.D.'s/Pop		
Coefficient	43.2056	1,726.5751***
Standard Error	(127.7326)	(655.8983)
T-stat	0.3363	2.6324
P-Value	(0.7352)	(0.0085)
Total Active Dentists/Pop		
Coefficient	547.9230	-3,092.3762
Standard Error	(657.2654)	(1,933.4551)
T-stat	0.8336	-1.5994
P-Value	(0.4046)	(0.1099)
Eligible for Medicare/Pop		
Coefficient	-10.3405	-12.7291
Standard Error	(6.5337)	(16.0536)
T-stat	-1.5826	-0.7929
P-Value	(0.1136)	(0.4279)

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